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PRODUCT PROCESS Engineering

REPORT NO. 8-8-50G-1

MONTHLY PROGRESS REPORT

ENGINEERING PROGRAM FOR THE
DEVELOPMENT OF A LIGHTWEIGHT
ANTI-TANK ROCKET

FOR THE PERIOD

MONTH OF AUGUST 1958

CONTRACT NO. RD-142

[redacted]

[redacted]

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FLIGHTEX FABRICS, INC.

PROGRESS REPORT #12

ENGINEERING PROGRAM FOR THE DEVELOPMENT OF A LIGHTWEIGHT ANTI-TANK ROCKET

AUGUST 1958

CONTRACT NO. RD-142

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SUBMITTED BY: HESSE-EASTERN DIVISION
FLIGHTEX FABRICS, INC.
EVERETT, MASSACHUSETTS

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WORK DONE DURING THE MONTH OF AUGUST 1958

SYSTEM EVALUATION PROGRAM

The program of re-evaluation of the interior ballistics, mentioned in the July Progress Report, was completed during the month. Static tests have been completed and confirmed by dynamic flight tests. The propellant configuration thus arrived at may be considered as final. Out-of-launcher burning and double burning have been eliminated.

The new method of setting off the primer in the ignition system has been checked out, and is being finalized. With the completion of the above tasks, the project has started its finalizing stage. Final components for motors and HEAT heads are expected during September and early October. The two areas which still need to be checked out are the launcher tube and the fuze.

MOTOR DEVELOPMENT PROGRAM

INTERIOR BALLISTICS

Evaluation of the results obtained during July and August by static firings show that configuration No. 1, i.e., a reduction in the wall thickness of the propellant of .010" and an increase of the propellant length to a dimension of 4.92", will result in satisfactory interior ballistics. The following table shows the results of an additional static test conducted 14 August 1958:

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Round No.	Dev.	10% B. T.	Max. Press.	P. T. Integral	Mean Press.
133	651	.013	5,333	605	3,255
134	850	.012	6,850	655	3,820
135	351	.014	5,633	644	3,790
136 Rods	100	.0135	6,084	6,335	3,750
137 Rods	849	.013	6,833	640	3,940
138 Rods	309	.015	5,675	6,449	3,419
139 Rods	517	.016	5,467	6,552	2,870

Average Maximum Pressure: 5,984

The curves are shown in photographs with the corresponding numbers in the appendix. The burning time has been reduced to a value of .020 seconds with the cold temperature rounds. This should terminate the burning of the propellant still within the launcher.

Based on the results of the static tests, a dynamic test was conducted on 12 August 1958. Eight rounds were fired at the cold temperature and eight at the hot temperature using propellant with and without aluminum rods. The tabulation of this test was as follows:

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FLIGHT TEST WITH .620 DIAMETER, 4.92 LONG PROPELLANT STICKS

METHOD OF IGNITION USED: ELECTRIC/LAUNCHER TUBE - STEEL

1004 ds

Round No.	Temp.	Type of Prop.	Vel. (F/S)	Out-of-Launcher Burning	Target Hit	Elevation In Mils
263	+130	No Rods	308	No	Low Left	80
264	+130	No Rods	296	No	Low Center	80
265	+130	Al. Rods	308	No	Low Center	90
266	-30	No Rods	266	No	Low	100
267	-30	No Rods	[redacted]	No	Center	110
268	-30	Al. Rods	250	No	Center	110
269	+130	Al. Rods	308	No	Center	100
270	-30	Al. Rods	286	No	Center	110

EVALUATION OF RESULTS

It appears that with an additional elevation of the launcher, sufficient accuracy will be obtained in spite of the lowered velocity figures. Out-of-launcher burning has been completely eliminated. It was therefore decided to adopt combination No. 1 and freeze the design. There was no significant difference between configuration No. 1 and configuration No. 2 (aluminum rods inside propellant) to justify into going into combination No. 2. A number of static curves at the hot temperature show a rather marked peak for an extremely short

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time duration. The reason for this was first thought to be trouble with the instrumentation. However, after carefully checking the instrumentation and the scope, it appeared certain that these were valid time-pressure traces. The largest number of them appeared in the last static test (14 August 1958). The best example is photograph No. 134. However, the mean pressure, maximum pressure and burning time of such rounds are satisfactory, and the impulse obtained would be so close to the impulse obtained from a trace such as shown on photograph Nos. 112, 114 and 116. These traces show a plateau rather than a marked peak. After careful study and evaluation of the static test results and of the impulse obtained from the dynamic rounds, the conclusion was reached that consistency will be satisfactory and the danger of motor failures practically non-existent. The ballistic computation sheet for round Nos. 263 through 270 is shown in the appendix.

IGNITION AND ACCURACY

In order to complete the test run on 25 July 1958, two more rounds were fired on 7 August 1958. These rounds were a repeat of round Nos. 249 and 251. The results were as follows:

RE-FIRING OF ROUND NOS. 249 and 251 (SEE PAGE 4 of JULY REPORT)

Round No.	Temp.	Comb.	Vel. (F/S)	Target Hit	Out-of-Launcher Burning	Comments
259	+140	2	340	Center	None	Re-fire of No. 249
260	+140	2	335	Center	None	Re-fire of No. 251

It was not necessary to re-fire the remaining rounds lost during the test on 25 July 1958 since they belonged to the group with the screen in the igniter. This design did not work at the low temperature and was therefore abandoned.

In order to further confirm ignition and interior ballistics with the new combination in the igniter and with the new propellant sticks, a flight test of 10 rounds was conducted on 27 August 1958. On the previous day one round, No. 271, was fired at ambient temperature. This round had a velocity of 308' per second and with a launcher elevation of 100 mils went over the target. The new ignition system worked perfectly.

IGNITION AND ACCURACY AT 100 METERS; IGNITER: MODEL 4;

LEVER OPERATED; TEMPERATURE -30°; LAUNCHER ELEVATION 110 MILLS

Round No.	Vel. (F/s)	Target Hit	Out-of-Launcher Burning	Comments
272	286	Center Left	None	Unstable
273	286	Center High	None	5 Minute Delay Before Firing Caused by Faulty Wiring
274	286	Center High	None	Some Delay
275	286	Center High	None	Some Delay
276	286	Center	None	Afterburn at 10 feet
277	286	Center	None	3 Minutes Delay
278	286	Center	None	Afterburn at 4 feet
279	286	High Left	None	Unstable
280				Motor Failure
281	286	Center	None	

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EVALUATION OF TEST RESULTS

With the exception of round No. 280, it may be stated that the accuracy and ignition on all rounds fired are satisfactory. The test was conducted with all rounds at the low temperature since ignition troubles and out-of-launcher burning are most apt to show up under those conditions. A motor failure occurred with round No. 280. This failure upon examination proves to be a brittle one. It has to be noted that all motors used in this test have been fired two or three times previously. The motors had been hard anodized in order to reduce erosion. This process has been very successful in enabling us to re-use motor bodies. However, a failure of a motor which has been fired repeatedly is probably attributable to the repeated stresses to which it has been subjected.

The accuracy of the rounds were more than adequate for the purposes set forth in the contract. However, two rounds showed a certain amount of instability. The final design of the tail fins will probably correct any such possibility in the future. The band to which the fins are attached in the final design is 1/8 of an inch wider, and there is no possibility, however remote, of any fins catching in the fastening screws.

This test also checked out the reliable functioning of the new igniter firing pin design as shown in the sketch in the July Progress Report (page 6). This will be further discussed in the launcher section of the report.

As a result of the above, the production order to the Harvey Aluminum Company on the final motor has been released, and the motor design, as well as

the igniter design, may be considered final. A short test program will be conducted in order to investigate whether a change can be made in the way in which the polyethylene is put over the igniter assembly. This would eliminate the raps of polyethylene in the throat area of the motor body and therefore facilitate producing a vapor moisture seal in that area.

Vapor moisture test equipment is expected to be available at our Rangeby mid-October, and tests as to water absorption in the motor cavity and other vapor moisture testing will then be conducted.

TAIL FINS

The final test fins are in the process of being manufactured, and test results have proven the tail fin design to be most sound and effective.

WARHEAD DEVELOPMENT PROGRAM

It is expected that final warheads will be assembled and loaded by the end of September and that dynamic testing can then be conducted. A crush-up test vs. time on the ogive has been conducted on the 4th of September with the following results:

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CONDITIONS: STEEL TARGET 40 FEET FROM LAUNCHER; CRUSH-UP OF OGIVE COMPUTED AGAINST .001 SECONDS AS INDICATED BY TIMING MARKS ON FILM; CAMERA SPEED 10,000 FRAMES PER SECOND; ALL ROUNDS AT AMBIENT TEMPERATURE; OLD (HEAVY WALL) PROPELLANT.

Round No.	Vel. F/S.	Crushed In .001 Sec.	Resulting Stand-Off	Comments
286	364	3.6	2.6	
287	348	3.5	2.7	
288	348	3.5	2.7	
289				No Picture; Round Too High
290	348	3.5	2.7	

It must be observed that, since the old propellant with its resulting higher velocities was used, a somewhat larger crush-up was to be expected than the crush-up obtainable with the new propellant. The stand-off resulting in this crush-up is roughly 3/8 of an inch short of the 3" which have produced the best results in static penetration tests to date. It is not known whether decreasing the stand-off under 3" would increase or decrease the penetration. The target in this test was at a distance of 40 feet from the launcher which is less than half the distance to be expected under actual combat conditions. A somewhat lower velocity can be expected at 50 meters and a lower velocity at 100 meters. The crush-up obtained in this test indicates that the ogive length is correct. It must always be kept in mind that a design of an ogive

for a mechanical fuze must always be a compromise. Conditions of impact are never exactly the same. However, functioning time of the fuze will be consistent. It follows that this will produce a variation in stand-off with any given ogive.

FUZE DEVELOPMENT PROGRAM

Fifteen static drop tests were conducted with three prototype fuze models, No. 4. The tests showed that setting back [redacted] of the fuzes were satisfactory and that the problem of bouncing has been overcome. The tests were conducted by dropping the fuze from a height of 20 feet on a steel plate. In three cases the fuzes were found only partly armed. One of the spring plungers had started the rotation of the rotor. However, the second plunger had not moved forward to complete it. Some modifications were made to the drawings to eliminate this condition, and a set of 50 components was ordered in the middle of August. It is expected that fuze assemblies will be available for testing by late September. Dynamic test with the same three prototype fuzes was conducted on 4 September 1958.

CONDITIONS: STEEL LAUNCHER AT 0 ELEVATION; ROUNDS GRAZED EARTH AT APPROXIMATELY 60 YARDS. MODEL 4 FUZE PROTOTYPES WITH DUMMY DETONATORS USED: NEW PROPELLANT

Round No.	Vel. F/S	Fuze Operation	Comments
283	308	OK	Grazed Flat at 60-70 Yards
284	[redacted]	OK	Grazed Flat at 60-70 YARDS
285	296	Partly Armed	Plunger Operating Second Part of Rotation Stuck

The fuzes used in this test contained dummy detonators, and every precaution was taken to damage the fuze parts as little as possible in the course of the test in order to make a thorough analysis of the parts after firing.

Round No. 285 did not fully arm. The plunger controlling the second part of the rotation of the rotor did not move forward. Upon examination of the fuze, it was found that a small chip had lodged in the hole containing the locking ball operated by this plunger. This appears to be the only reason why the fuze did not fully arm. Further tests will have to be conducted in order to determine whether a fuze will arm reliably. Based on the test of 4 September 1958, it may be stated that graze sensitivity has been greatly improved and the safety pin design further checked out. All safety pins released properly when the rocket was launched.

LAUNCHER DEVELOPMENT PROGRAM

An intensive program of obtaining stronger launcher tubes has been underway, and two tubes of supposedly good strength characteristics have been delivered and tested. One was tested hydrostatically and showed a bursting strength of only 900 psi. The other sample tube which was obtained was subjected to a pendulum test at the Range when a cold round was fired through it without inner sleeve. Round No. 282 was fired at - 30°. A 5-pound weight was attached to the launcher. A motion picture shows the marked motion of only 18". However, no timing marks are available on the picture, and no impulse can therefore

be computed. If comparing this result to previous results, it may be stated that the impulse is of about the same order. After subjecting the launcher tube to this test, it was hydrostatically tested for burst pressure. The burst pressure was only 150 psi. This shows that this particular tube is unlikely to be strong enough to be used.

Three different suppliers have been consulted and are in the process of making up some of the tubes for us to test. It must be pointed out that failure of a launcher tube at the cold temperature occurred before the interior ballistics were changed. The change of the interior ballistics has caused andecrease in burning time and a drop in pressure. It is therefore possible that the old tubes will have sufficient strength. It is felt that all efforts must be made to finalize with as strong a launcher tube as possible in order to have a maximum safety factor without unduly increasing the weight and cost of the system.

The following types of tubes are being investigated:

1. G. E. Textolite tubes parallel wound using an epoxy resin bond. Also, fiberglas tubes from the same supplier.

2. Richardson Company paper tubes and cloth tubes using a linen base.

3. Babbitt Pipe Company, who has been supplying the tubes used for testing until now.

As soon as sample tubes are received, they will be subjected to a hydrostatic test to determine the bursting strength and dynamic tests on a pendulum to determine launcher strength and to obtain further data on recoil.

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IGNITER ASSEMBLY

The new igniter assembly as shown in a cutaway view on Photograph No. 140 (Appendix). The cross-piece used in the cutaway model was machined from an aluminum block. The tooling required for a new cross-piece has been ordered, and it is expected that components for static and dynamic tests will be available by the middle of September.

The new design was statically tested without any failure occurring on 50 tests. Ten assemblies were used in the flight test of 27 August 1958. All worked properly. Further work is being done on determining the amount of pull necessary to operate the new design. The feel of the trigger, with a load of approximately 16 pounds required, is slightly lighter than the old design.

Twenty sets of launcher components will be put into manufacture as soon as the current test program justifies freezing the design. This will make it possible to test complete systems at both extremes of temperature.

Evaluated vs. costs expended for the month

$12,642.14

Charles B. Weeks
General Manager

Thomas Forman
Project Engineer

FLIGHT DATA - BALLISTICS COMPUTATION SHEET

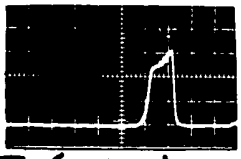
1.	ROUND NO.	263	264	265	269	266	267	268	270
2.	VELOCITY (FT/SEC)	286	267	278	299	236	---	250	286
3.	PROP. WEIGHT (LBS.)	.093	.093	.093	.093	.093	---	.093	.093
4.	1/2 PROP. WEIGHT	.047	.047	.047	.047	.047	---	.047	.047
5.	PROJECTILE WEIGHT	3.51	3.5	3.56	3.2	3.52	---	3.62	3.24
6.	EFF. WEIGHT (4 + 5)	3.557	3.547	3.607	3.247	3.567	---	3.667	3.287
7.	IMP. $\frac{(6 \times 2)}{g}$	31.6	29.4	31.4	30.2	26.0	---	28.5	29.2
8.	SPEC. IMP. $\frac{7}{3}$	340	316	338	325	280	---	306	314
9.	TEMPERATURE	+130	+130	+130	+130	-30	---	-30	-30

340
316
338
325
306
314
1939

326

PHOTOGRAPHS

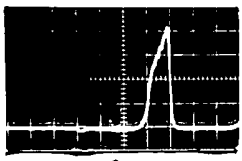
PHOTO #133



10% B.T. (ADJ.) = 13 M.S.
MAX. PRESS. = 5,333 PSI
MEAN PRESS. = 3255 PSI
PRESS AREA = .07

Photograph No. 133

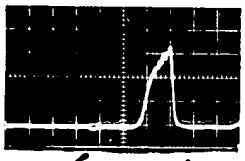
PHOTO #134



10% B.T. (ADJ.) = 12 M.S.
MAX. PRESS. = 6,850 PSI
MEAN PRESS. = 3,820 PSI
PRESS AREA = .07

Photograph No. 134

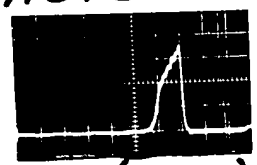
PHOTO #135



10% B.T. (ADJ.) = .[redacted] 14 MS.
MAX. PRESS. = 5,633 PSI
MEAN PRESS. = 3,790 PSI
PRESS. AREA = .08

Photograph No. 135

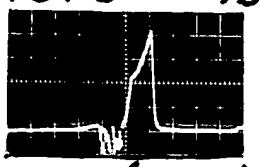
PHOTO #136



10% B.T. (ADJ.) = 13 MS
MAX. PRESS. = 6,084 PSI
MEAN PRESS. = 3,750 PSI
PRESS. AREA = .08

Photograph No. 136

PHOTO # 137



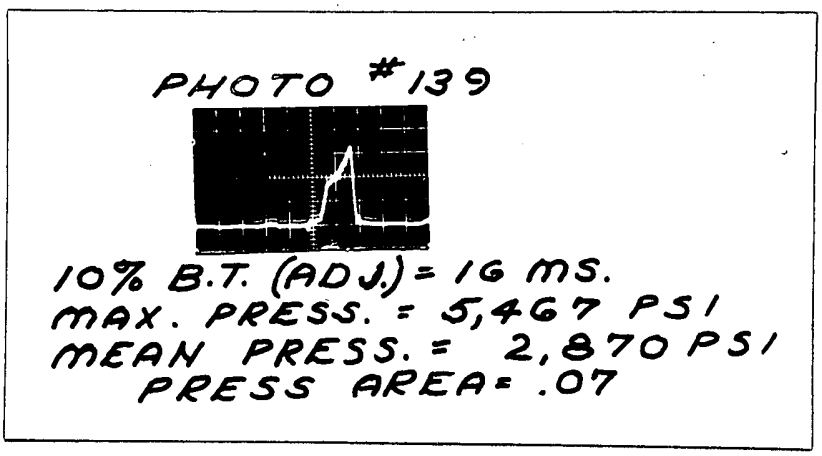
10% B.T. (ADJ.) = 13 MS.
MAX. PRESS. = 6,833 PSI
MEAN PRESS. = 3,940 PSI
PRESS. AREA = .08

Photograph No. 137

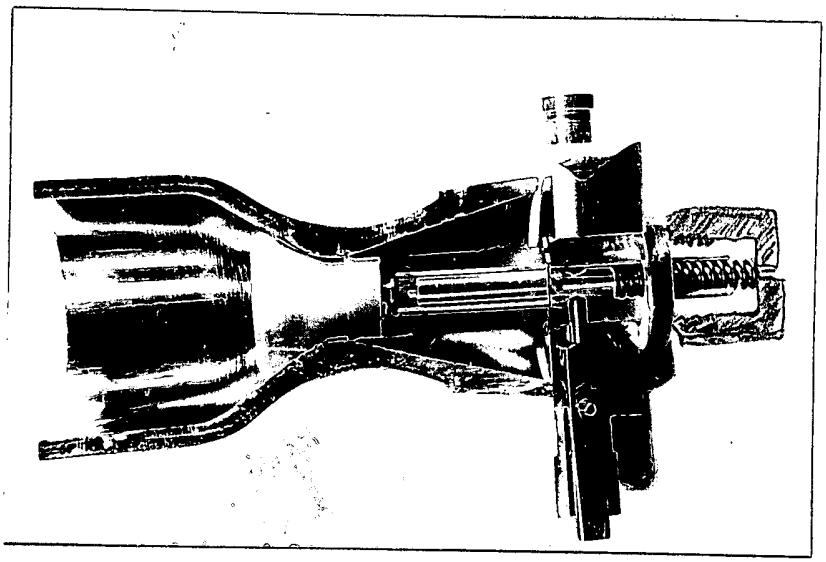
PHOTO # 138

10% B.T. (ADJ.) = 15 MS.
MAX. PRESS. = 5,675 PSI
MEAN PRESS. = 3,419 PSI
PRESS. AREA = .08

Photograph No. 138



Photograph No. 139



Photograph No. 140

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